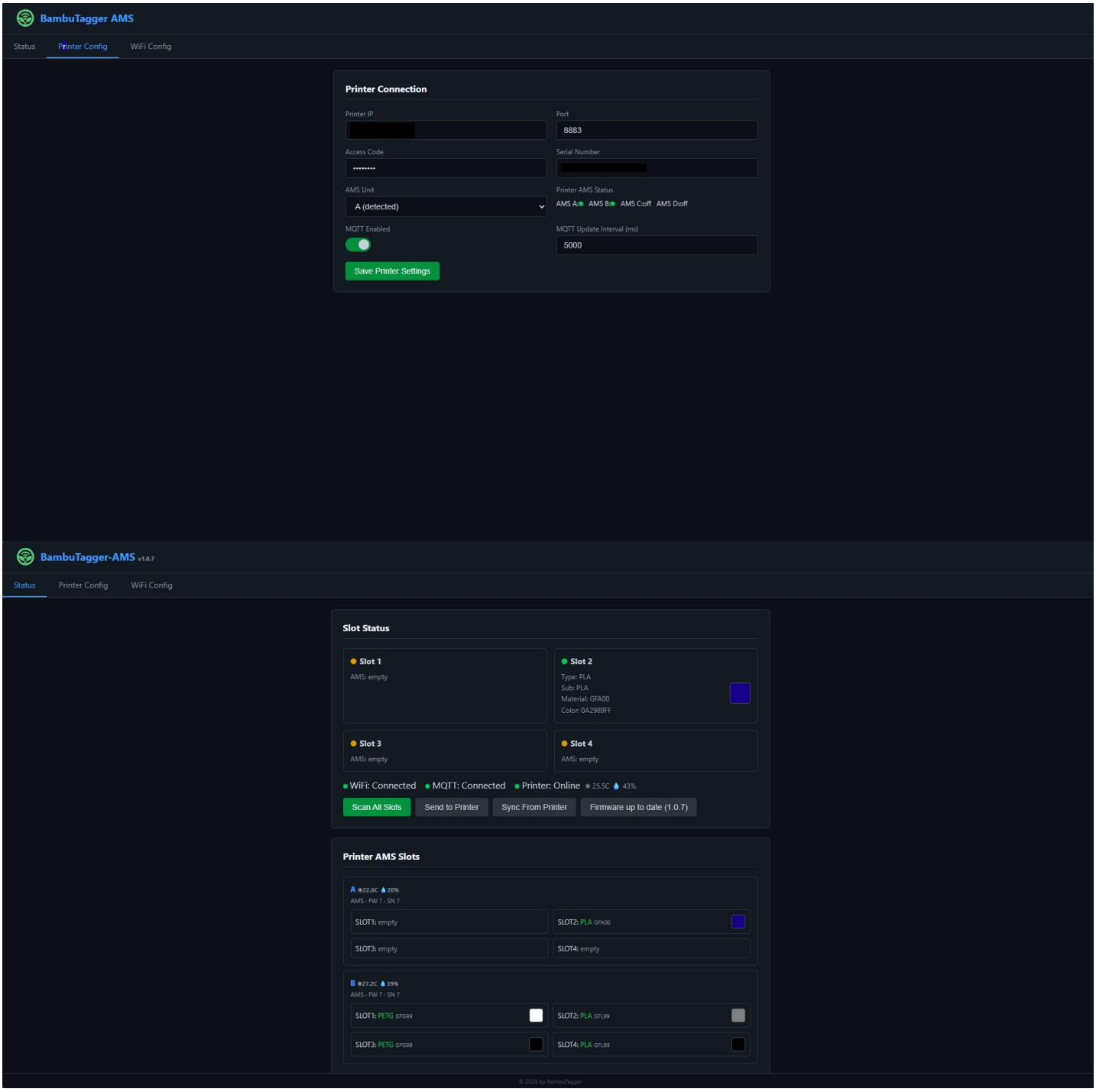
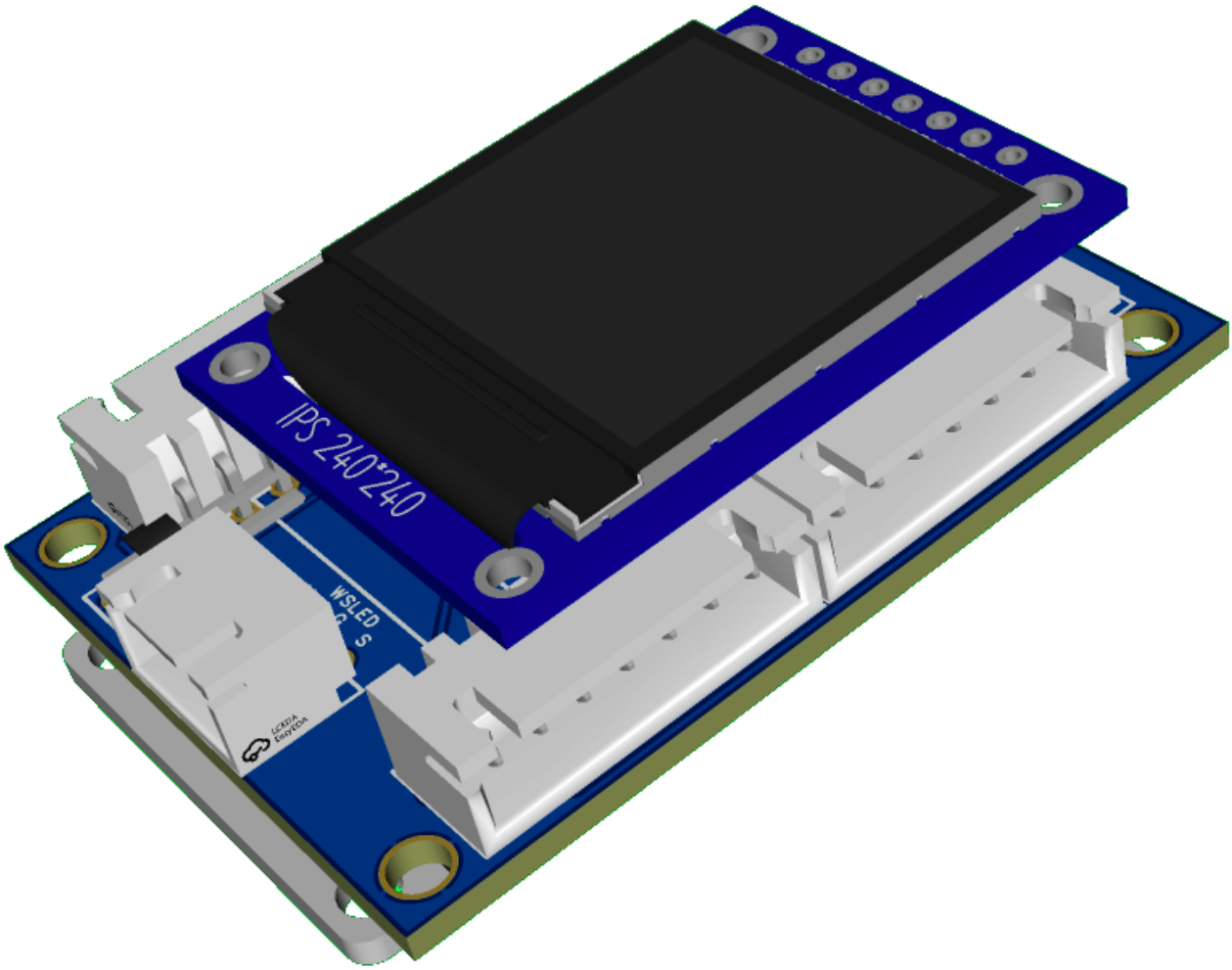
BambuTagger-AMS-C

Multi-spool NFC tag reader for Bambu Lab printers. Reads 4 Bambu Lab lament spool tags via RC522, displays live printer AMS tray data over MQTT, and sends RFID tag data to the printer/BMCU. Fully con gurable via web interface with automatic AP fallback and OTA rmware updates.

Support me on Ko-fi





Features

Category	Details
RFID	4x RC522 on shared SPI bus; MIFARE Classic 1K (Bambu Lab) + NTAG (SpoolEase/TigerTag/OpenTag3D/OpenSpool) auto-detection
Key derivation	HKDF-SHA256 with Bambu Lab salt — no hardcoded keys
Tag parsers	TigerTag v2.1 binary, OpenTag3D MIME binary, OpenSpool JSON, SpoolEase NDEF URI, nested NDEF recursion
Live AMS sync	Reads tray data (material, color, type) from printer over MQTT
BMCU support	Sends `ams_filament_setting` with correct `tray_type` , `tray_color` , `nozzle_temp_min/max`
TFT display	240×240 1.3" ST7789VW with boot splash, live AMS tray data, OTA progress, BME280 temp/humidity
Category	**Details**

LEDs	4x WS2812 addressable LEDs with per-slot color from printer AMS tray data
Web UI	3-tab SPA: Status (merged slots + color swatches), Printer Con g, WiFi Con g
MQTT bridge	Subscribes to printer status, publishes `ams_filament_setting` commands
WiFi	Auto-STA on boot; AP fallback `192.168.4.1` with captive portal
OTA updates	One-click rmware update from GitHub Releases with TFT progress bar
CI/CD	GitHub Actions: build on commit, release on version tags

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Hardware

Bill of Materials

Component	Notes	Buy
ESP32 Dev Module	Base board	https://de.aliexpress.com/item/1005006589341221.html
4x RC522 RFID/NFC readers	SPI interface, shared bus	https://de.aliexpress.com/item/1005006233005745.html
4x WS2812 addressable LEDs	Daisy-chained, single data pin	https://de.aliexpress.com/item/32560280169.html
240×240 1.3" TFT	ST7789VW SPI display	https://www.aliexpress.com/item/1005007094147766.html
BME280 sensor	Temperature/humidity, I2C	https://de.aliexpress.com/item/1005006824236173.html
PCB	DIY PCB from JLPCB	https://oshwlab.com/bambutagger/project_hdkkdlsn

Pin Assignments

SPI Bus (shared by all RC522 readers)

Signal	GPIO
MOSI	23
Signal	**GPIO**
MISO	19
SCK	18

RC522 Readers

Reader	SS Pin	RST Pin	Slot	WS2812 Pixel
#1	13	26	1	0
#2	12	25	2	1
#3	14	33	3	2
#4	27	32	4	3

TFT Display (ST7789VW SPI)

Signal	GPIO
SDA (MOSI)	17
SCL (SCK)	16
DC	4
RES	5
BLK (Backlight)	2

WS2812 LEDs

Signal	GPIO
Data	15

Software

Required Libraries (Arduino Library Manager)

Library	Version	Notes
`MFRC522-spi-i2c-uart-async`	latest	Multi-reader SPI sharing (not standard MFRC522)
`Adafruit NeoPixel`	≥ 1.12	WS2812 LED control
Library	**Version**	**Notes**
`Adafruit GFX Library`	≥ 1.11	Graphics primitives
`Adafruit ST7735 and ST7789 Library`	≥ 1.10	TFT display driver
`PubSubClient`	≥ 2.8	MQTT client
`ArduinoJson`	≥ 6.x or 7.x	JSON parsing

`Adafruit BME280 Library`	latest	Temperature/humidity sensor
`mbedTLS`	Built-in	HKDF-SHA256 key derivation

Board Settings (Arduino IDE)

Setting	Value
Board	**ESP32 Dev Module**
Flash Size	**4 MB**
Partition Scheme	**Default 4MB with spiffs**
Upload Speed	921600
Monitor Speed	**115200**

Building

. Install **ESP32 board package** (≥ 3.x):

File ⟶ Preferences ⟶ Additional Board Manager URLs:

```
https://espressif.github.io/arduino-esp32/package_esp32_index.json
```

. Install libraries listed above via **Tools ⟶ Manage Libraries**.

. Open `BambuTagger-AMS-C.ino` , select **ESP32 Dev Module**, and upload.

WiFi & AP Mode

Scenario	Behavior
No WiFi con gured	Opens AP immediately
WiFi connection fails	Opens AP after 15 seconds
AP active, credentials exist	Retries STA connection every 30 seconds
Scenario	**Behavior**
STA connects while AP active	Closes AP, switches to normal mode

AP Details:

- **SSID**: Device name (default: `BambuTagger-AMS`)
- **Security**: Open (no password)
- **IP**: `192.168.4.1`
- **Captive portal**: DNS redirects all domains to the con g page

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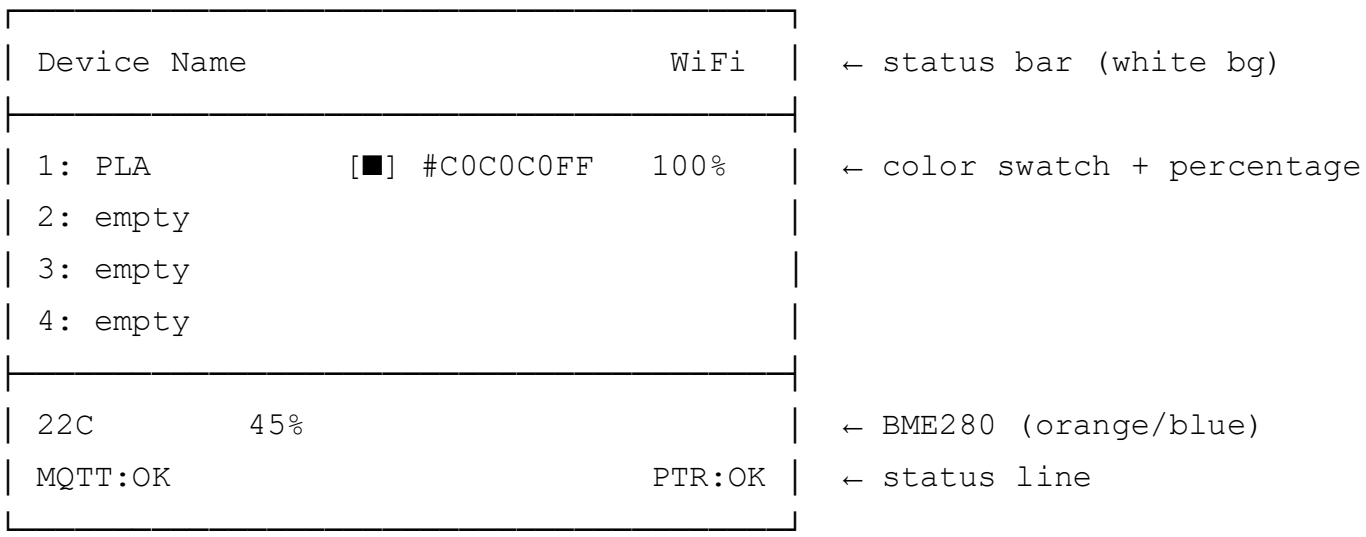
Web Interface

Open a browser to the ESP32's IP (shown on TFT), or `http://192.168.4.1` in AP mode.

Tab	Description
Status	Merged slot status with AMS data + scanned tag data, color swatches, printer AMS cards, OTA button
Printer Con g	Printer IP, Port (8883), Access Code, Serial Number, AMS Unit selector (A/B/C/D), MQTT settings
WiFi Con g	SSID, Password, Device Name

TFT Display (240×240 1.3" ST7789VW)



OTA progress shown on TFT with header/footer preserved:

"OTA Update" → "Downloading..." → "Flashing... 45%" → auto-reboot

Printer Communication

Subscribe

- **Topic**: `device/<serial>/report`
- **Data**: `push_status` (periodic, ~3KB), `get_version` responses

Publish

Topic: `device/<serial>/request`

`ams_filament_setting` structure:

```
{
  "print": {
    "sequence_id": "0",
    "command": "ams_filament_setting",
    "ams_id": 0,
    "tray_id": 0,
    "tray_info_idx": "GFA00",
    "tray_color": "RRGGBBFF",
    "nozzle_temp_min": 190,
    "nozzle_temp_max": 230,
    "tray_type": "PLA"
  }
}
```

- `tray_type` derived from lament index pre x (GFA→PLA, GFG→PETG, etc.)
- `tray_color` forced to RRGGBBFF format
- `nozzle_temp_min/max` from tag block 6

Tag Format & Reading

Supported Tag Types

Tag Type	Format	Example
Bambu Lab	MIFARE Classic 1K	`Bambu - PLA · C12E1FFF · 1000g/1000g`
Tag Type	**Format**	**Example**
SpoolEase	NTAG, NDEF URI	`SpoolEase - PLA · 000000FF · 1000g/1036g`
TigerTag	NTAG, binary v2.1	`TigerTag - ASA-AF · F078B4FF · 1000g/1000g`
OpenSpool	NTAG, NDEF JSON	`OpenSpool - ASA-AF · F078B4FF · 1000g/1000g`
OpenTag3D	NTAG, MIME binary	`OpenTag3D - ASA-AF · F078B4FF · 1000g/1000g`

Bambu Lab (MIFARE Classic 1K)

Block	Content
0	UID (4 bytes)
1	Variant ID + Material index (e.g. "GFA00")
2	Filament type short name

4	Detailed type string (e.g. "PLA Basic")
5	RGBA color (bytes 0-3) + spool weight LE (bytes 4-5)
6	Nozzle temps (bytes 8-11 LE)

SpoolEase (NTAG, NDEF URI)

URL format: `https://tag.spoolease.io/S1/?TG=...&M=PLA&CC=000000FF&SC=GFL99&WL=1000&WE=179&WF=1215&NN=190&NX=240`

Param	Field	Description
`M=`	display type	e.g. "PLA", "PETG"
`SC=`	`materialType`	Bambu index for MQTT (e.g. "GFL99")
`CC=`	`colorHex`	RGBA hex (e.g. "000000FF")
`B=`	`manufacturer`	Brand name (e.g. "Jayo")
`WL=`	`remainingGrams`	Remaining lament weight
`WE=`	empty spool	Empty spool weight
`WF=`	full spool	`totalGrams = WF - WE`
`NN=`	`nozzleTempMin`	Min nozzle temp °C
`NX=`	`nozzleTempMax`	Max nozzle temp °C

TigerTag (NTAG, binary v2.1)

Offset	Size	Field
+0	4	ID TigerTag magic (0x5BF59264/0xBC0FCB97/0x6C41A2E1)
+4	4	Product ID
+8	2	Material ID → lookup table (PLA/PETG/ABS/TPU...)
+14	2	Brand ID
+16	4	Color 1 RGBA
+20	3	Measure (u24 BE)
+24	2	Nozzle Temp Min
+26	2	Nozzle Temp Max
+76	3	Measure Available

Known material IDs: PLA=38219, PETG=38256, ABS=20562, etc.

Authentication & Reading

- **Tag auto-detect**: SAK-based type detection (MIFARE 1K vs NTAG)
- **HKDF-SHA256** derives 16 per-sector Key A/B from 4-byte UID
- Bambu KDF salt/info vectors from reverse-engineered rmware
- Falls back to default key `0xFF...FF` for blank sectors
- Failed auth re-wakes tag via antenna power-cycle
- Dead readers auto-skipped (version register 0x92/0x91/0xB2 check)
- SPI: 1 MHz via `MFRC522_SPI`
- NTAG: page-level reads (page+=4, 4 pages per MIFARE_Read)

Filament Type Mapping

Pre x	Type
GFA-GFE, GFL	PLA
GFG	PETG
GFH, GFI	ABS
GFJ	ASA
GFK	TPU

OTA Updates

- **Button**: "Update Firmware" on Status page (shows "Update to vX.Y.Z" or "up to date")
- **Overlay**: full-screen progress overlay with spinner, status text, progress bar
- **Endpoint**: `POST /api/ota` triggers update, `GET /api/ota-check` checks for newer version
- Downloads latest `.ino.bin` from GitHub Releases, ashes via `Update.h`
- 3 retry attempts with 5s stall detection, fresh HTTP client per attempt
- TFT shows "Checking version..." → "Downloading..." → "Flashing..." with percentage
- Device auto-reboots after successful ash, web UI auto-reloads

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CI / CD

Work ow at `GHActions/release.yml` :

- **On push/PR**: compiles sketch, uploads artifacts
- **On release tag**: creates merged ash binary + OTA binary, attaches to GitHub Release Arduino
- cache for fast rebuilds, pinned esp32:esp32@3.0.7 core

Con guration Defaults

Setting	Default
WiFi SSID	(empty)
WiFi Password	(empty)
Device Name	BambuTagger-AMS
Printer IP	192.168.1.100
Printer Port	8883
Access Code	(empty)
Printer Serial	(empty)
AMS Unit	A (0)
MQTT Enabled	Yes
MQTT TLS	No
MQTT Update Interval	3000 ms
Setting	**Default**
RFID Poll Interval	100 ms
Firmware Version	1.0.8

Credits & References

- RFID-Tag-Guide
- Display library: Adafruit ST7735/ST7789
- RFID library: MFRC522-spi-i2c-uart-async
- OpenTag3D spec: opentag3d.info

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